

Very preliminary draft
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**Returns to Education and Wage Inequality:
Evidence from Chile**

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1. Introduction

In Chile as well as in other Latin American countries the issue of income inequality is at the front of the political debate. The region ranks ahead of Africa as the most unequal in the world. Chile, at the same time, is one of the most unequal countries in the Latin American region. In the last 15 years Chile has had an extraordinary economic expansion with an increase in income per capita at an annual rate of 5,3%. In the mid 1970s the country witnessed the beginning of one of the most ambitious economic programs ever. Chile moved from a highly interventionist economy to one of the most open economies in the world. In a 4 year period tariffs were reduced from an average of 120% ranging from 0 to 750% to an even tariff of 10%. 1000 controlled prices were liberated. Several firms were privatized. In 1981 a broken pay-as-you-go social security system was replaced by one of individual although mandatory savings accounts. Most of these reforms were praised world wide¹.

These reforms and the economic growth of the last years had however no positive impact on income inequality. Moreover the data shows that there has been a mild increase in income inequality in the last decade. Other Latin American countries that reformed their economies after the debt crisis of the 1980s experienced a similar situation. Income inequality remain high and in some cases increased after the reforms were introduced. Increasingly these reforms are blamed for the increase in income inequality. But of course the reforms cannot explained the long Latin American history of unequal incomes. Furthermore, in the case of Chile this tendency to a greater inequality started before the major reforms were introduced.

In this paper we try to build a better picture of the evolution of wage inequality in Chile. We used a technique developed originally by Juhn et. al. (1993) to decompose the changes in the wage distribution in Chile. We find that these changes are to a great extent attributable to changes in observable prices. These last changes on the other hand are mainly explained by the changes in the return to education, specifically an increase in the private return to university education and a fall in the returns to primary and secondary education.

Given these results an attempt is made to explain the causes behind the changes in the returns to education in Chile. No clear picture appears from that analysis. Finally a preliminary exploration in the consequences for income inequality in Latin America of uncommon structures of returns to education is made. Specifically, the possibility of a positive covariance between returns to education and schooling is brought to the discussion. If that is the case increases in schooling (keeping the variance of schooling constant) do not necessarily reduce income inequality.

2. Changes in wage inequality in Chile: a story of four decades

In this section we describe very briefly the changes in wage inequality in Chile. For those purposes we use the employment survey of the University of Chile, the only long run source of data in Chile. The data started to be collected in 1957 on a quarterly basis and covers the Great Santiago that represents around a 37% of the Chilean population. We use

¹For an analysis of Chile's road to free market see Edwards and Edwards, and Larraín and Vergara, eds., (2000).

the data on the June survey that collects also information on family incomes. We concentrate our analysis in men². The evidence in Chile shows that wage inequality has increased in the last decades. It reached a peak in the 80s went down in the 90s but is still above the 1960s figures. (Table 1.)

Table 1
Hourly wage inequality in Chile
(among male wage earners: Great Santiago)

	Gini	Variance log W	Log 90 - 50	Log 50 - 10
1960s	0.46	0.63	1.09	0.83
1970s	0.48	0.68	1.15	0.82
1980s	0.53	0.79	1.35	0.80
1990s	0.49	0.67	1.31	0.73

Source: own calculations based on Survey of Employment, University of Chile.

The increases in wage inequality are there but are not dramatic. The data shows however that the levels of inequality in Chile are high. Some have argued that the increase in inequality in Chile is explained by the economic reforms of the military dictatorship. The peak in inequality of the 1980s is used as evidence for that statement. Figure 1 suggest however that this tendency to a greater inequality as already present in the Chilean economy at the time of those reforms. The right hand side graph compares the late 1950s with the late 1960s and show that the top wage earners were having faster increases in their salaries than the people of the bottom half of the wage distribution.

Figure 1
Changes in the Log of the salary per hour

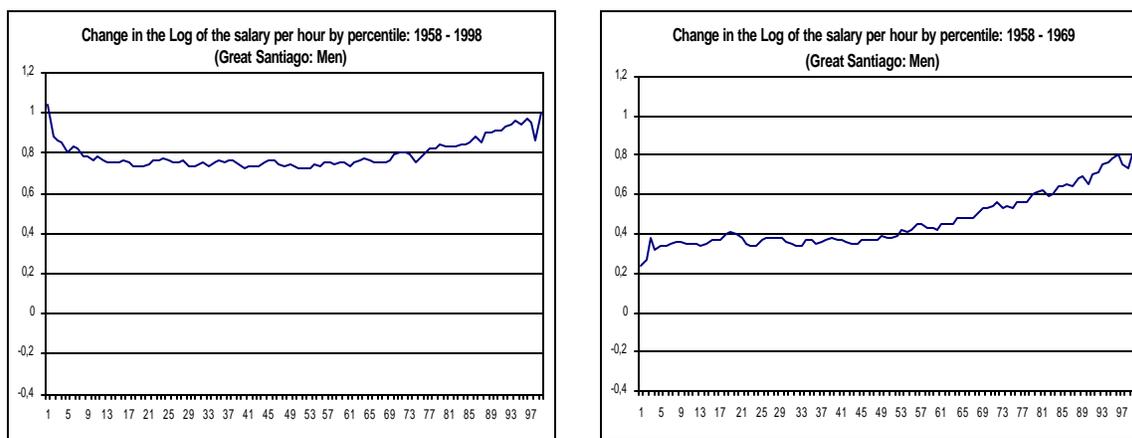
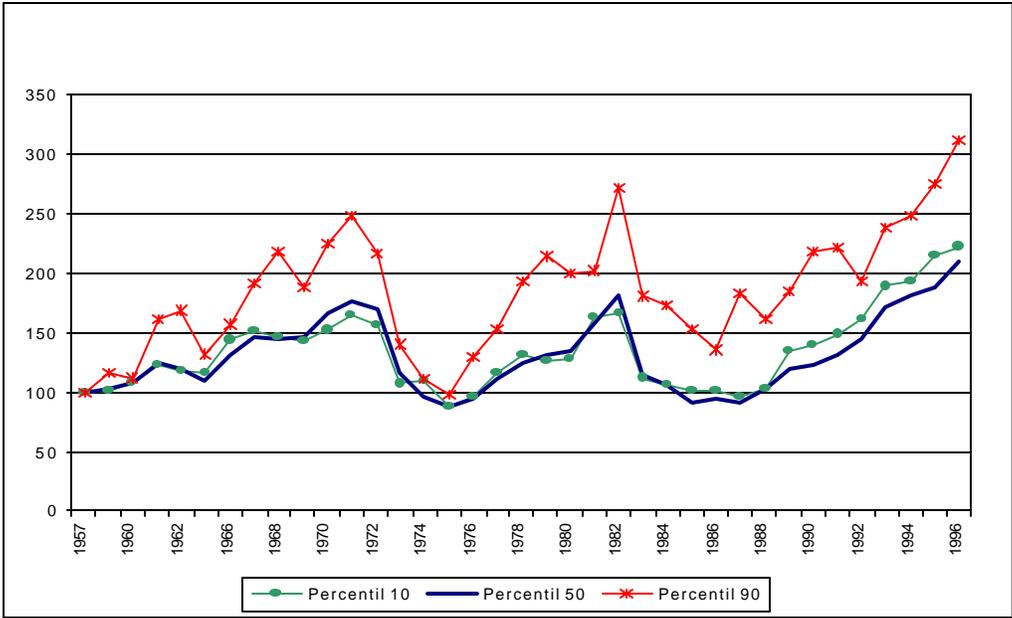


Figure 1, on the other hand, reaffirms the idea that there has been a compression at the bottom part of the distribution and an increase in the dispersion of the top half of the

²The labor participation of women is very unequal distributed according to educational level and has been countercyclical in Chile. The labor participation of men on the other hand has been very stable through time and there are no significant differences according educational level.

distribution. Moreover it also shows that the increase inequality has been accompanied of a general increase in wages which is not the case, for example, of the US where the real wage of the 10th percentile is currently below the 1960s levels. This statement is confirmed by Figure 2 that shows the hourly wage evolution for different percentiles.

Figure 2
 Index Male Hourly Wage
 (Chilean \$ 1996 Base 1960:100)



The increase in wages for the 10th and 50th percentile is however a recent phenomenon. The reduction in wages however can be traced to specific events. The economic crisis of 1973-75 and of 1982-83 when GDP per capita felt by 15 and 19%, respectively.

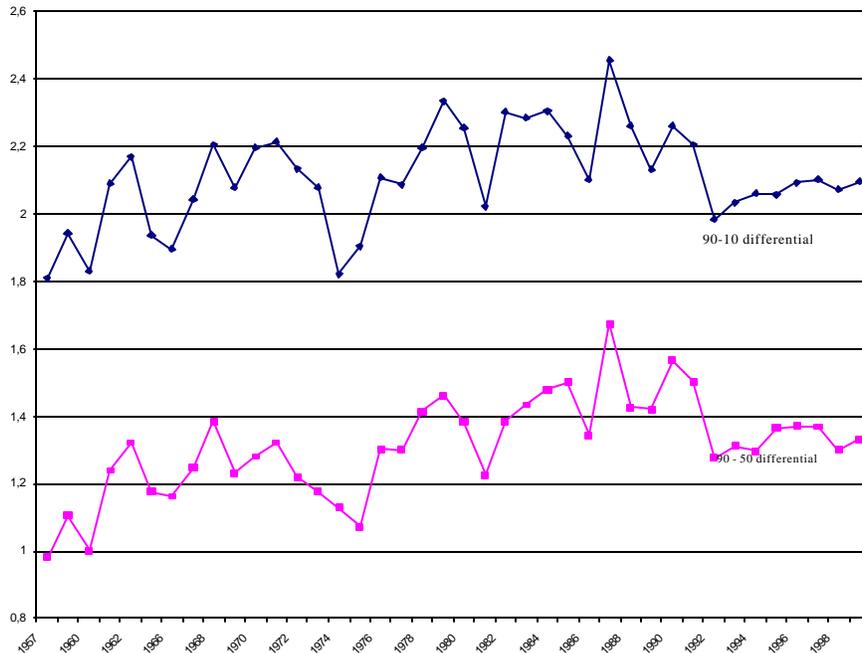
3. Wage inequality in Chile: educational attainment and returns to education

3.1 Components of the changes in wage inequality in Chile³

There is no doubt that there has been an increase in wage inequality in Chile. Figure 3 describes the complete evolution of the 90-10 differential and the 90-50 differential.

³This section owes a lot to current research developed by Beyer and Lefulon (2000)

Figure 3
Actual Percentile differentials of wage earners



Both the 90-50 differential and the 90-10 differential show an important, although not dramatic, increase in wage inequality. These increases began in the 1960s. The early 1970 witnessed a decrease in wage inequality but from the mid 1970s and until the end of the 1980 wage inequality was on the run. The 1990s have witnessed a stabilization at a lower level than the 1980s but above the early 1960s levels. Using a simple framework developed by Juhn et. al. (1993) we try to quantify the contribution of changing observable quantities, observable prices and unobservable. To isolate the different effects we use a simple human capital model such as

$$(1) \quad Y_{it} = X_{it} \beta + u_{it}.$$

where Y_{it} is the log monthly wage for individual i in year t . X_{it} represents a vector of individual characteristics including experience and education, marital status, industry and a broad definition of occupation⁴. Finally u_{it} accounts for the unobservable part of the wage equation. The idea is to think of this residual as two components: an individual's percentile in the residual distribution, θ_{it} , and the distribution function of the wage equation residuals, $F_t(\cdot)$. Then by definition of the cumulative distribution function we have

$$(2) \quad u_{it} = F_t^{-1}(\theta_{it}|X_{it})$$

where $F_t^{-1}(\cdot|X_{it})$ is the inverse cumulative residual distribution for workers with characteristics X_{it} in year t . In this framework changes in wage inequality come from three

⁴ We study only men that are wage earners and work full time.

sources: changes in the distribution of the X's, changes in the β 's, and changes in the distribution of the residuals. If an average price for observables over the entire period ($\bar{\beta}$), as well as an average cumulative distribution, $\bar{F}(\cdot | X_{it})$, are defined, it is possible to decompose the wage equation into corresponding components as follows:

$$(3) \quad Y_{it} = X_{it} \bar{\beta} + X_{it} (\beta - \bar{\beta}) + \bar{F}^{-1}(\theta_{it} | X_{it}) + [F^{-1}(\theta_{it} | X_{it}) - \bar{F}^{-1}(\theta_{it} | X_{it})].$$

The first term of equation 3 captures the effect of the change in the X distributions at fixed prices. The second terms captures the changes in the β 's at fixed X. The final term captures the effects of changes in the distribution of wage residuals. This decomposition permits the reconstruction of what the wage distribution would look like if any subset of components are held fixed. Specifically if we fixed observable prices and the residual distribution, the wage equation would be determined as

$$(4) \quad Y_{it}^1 = X_{it} \bar{\beta} + \bar{F}^{-1}(\theta_{it} | X_{it}).$$

So, if the distribution of Y_{it}^1 is calculated for each year we can attribute the change through time in inequality as the result of changes in observable quantities. Similarly if we want to allow observable prices and quantities to change over time but not the residual distribution we estimate wages by:

$$(5) \quad Y_{it}^2 = X_{it} \beta + \bar{F}^{-1}(\theta_{it} | X_{it}).$$

If we proceed as indicated any additional change in inequality in Y_{it}^2 over Y_{it}^1 can be attributed to changes in observable prices. Finally any additional increase in equality that comes from comparing the actual distribution of incomes to Y_{it}^2 should be attributed to the distribution of unobservables.

In Table 2 the results of this decomposition between the period that includes the year 1957, 1958 and 1959 and the period that includes the years 1997, 1998 and 1999 are presented. The results are very interesting and to some extent surprising. The increase in the 90-10 differential hides important changes within the distribution. In effect, the results corroborate the compression in the bottom half of the wage distribution accompanied by a dispersion in the top half of the distribution. Both phenomena are mostly explained by the changes in the distribution associated to observable prices. Unobservables play only a minor role in the changes in wage inequality in Chile. This result differs from the one find by Juhn et. al. (1993) for the US⁵. The changes in observable prices are almost entirely explained by changes in the return to different educational levels. We try to understand these changes in the next section.

⁵It should be mention that our specification allowed for differences in the b's according to educational level.

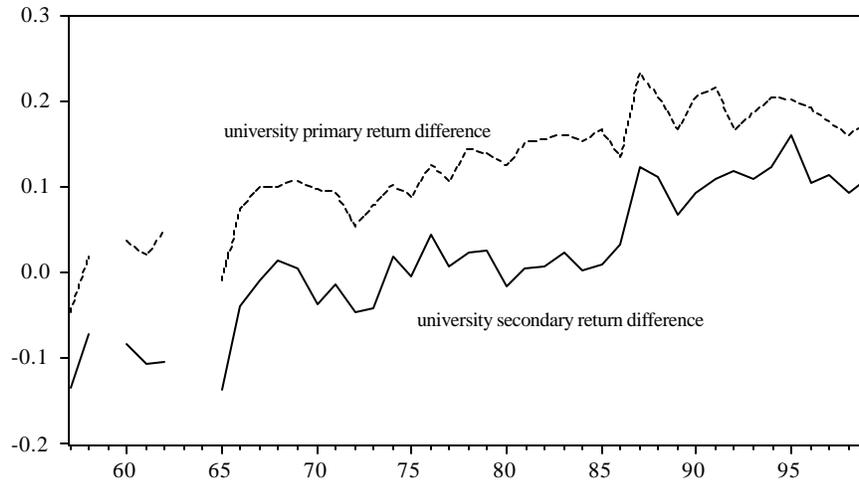
Table 2
Observable and unobservable components of changes in wage inequality

Differential	Total change	Observed quantities	Observed prices	Unobservables
90-10	0.227	0.110	0.019	0.099
90-50	0.315	0.085	0.184	0.046
50-10	-0.087	0.025	-0.165	0.053

3.2 Understanding the changes to education returns in Chile: a preliminary exploration

Average schooling has increased in Chile. However, educational differences did not diminish. Consequently an important explanation behind the changes in wage inequality are related to the increase in the differences in educational attainment among Chilean wage earners. But the evidence presented above shows that the change in the returns to education is also another important factor behind the widening of wage differentials in Chile. The figure 4 shows the evolution of the marginal private return to university education compared to secondary and primary education.

Figure 4
Differentials in the returns to education



The difference in returns appears to be non-stationary. This impression is corroborated once unit root tests are carried on. Table 3 shows the results of the ADF tests both under the assumption of no trend and trend.

Table 3: unit root tests

	τ_u	τ_t
University primary	-2,00	-2,93
University secondary	-1,58	-3,08

Note: critical values are -2.61 (10%), -2.95 (5%) and -3.64 (1%) if no trend is assumed, and -3,20 (10%), -3.55 (5%) and -4,26 (1%) if a trend is assumed.

The next stage is to look at the possible explanations behind the changes in the returns to the different educational levels. Different explanations for the behavior of these series have been offered. In figure 5 we plot the difference in university and secondary returns against several variables that have been offered as possible explanation of its evolution.

Figure 5
Possible explanations in the evolution of return differentials

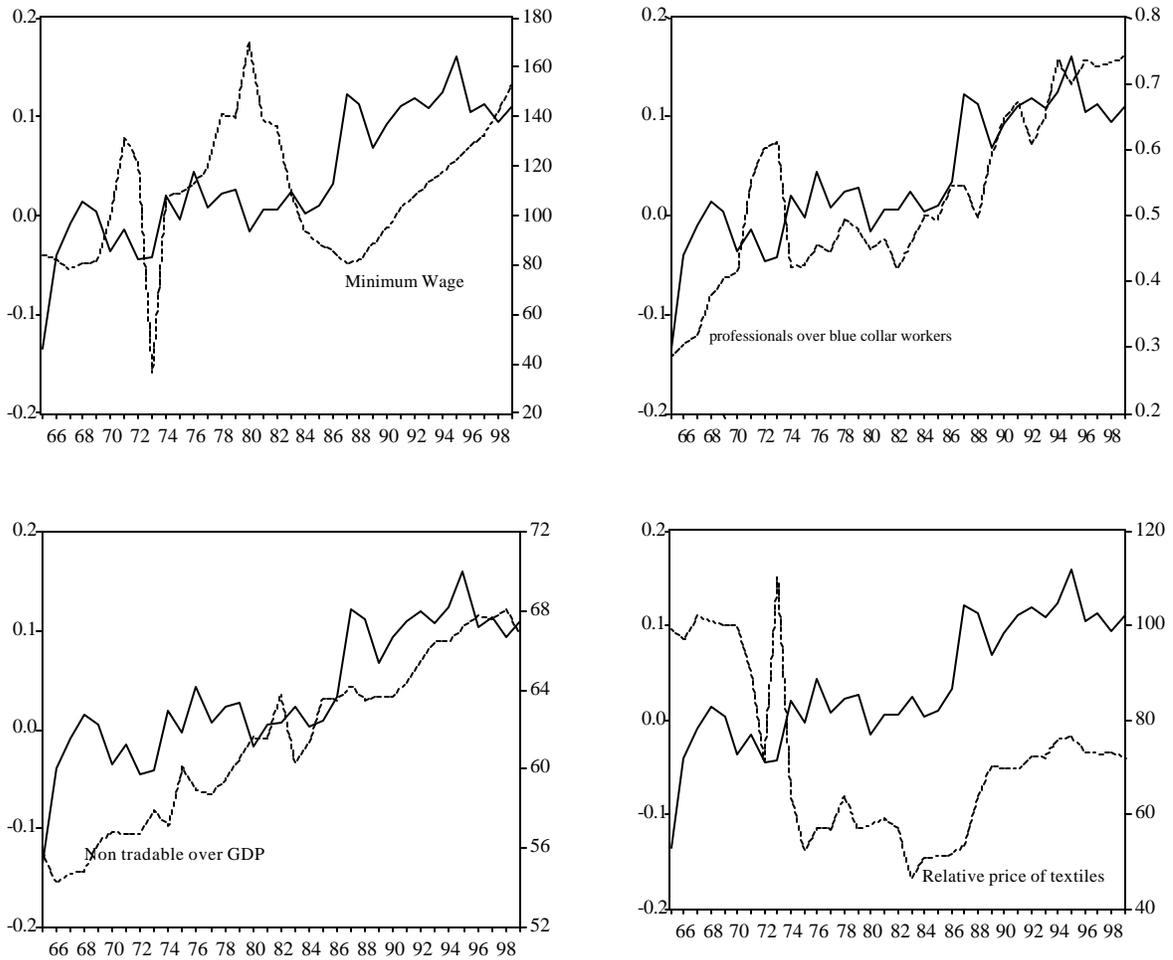
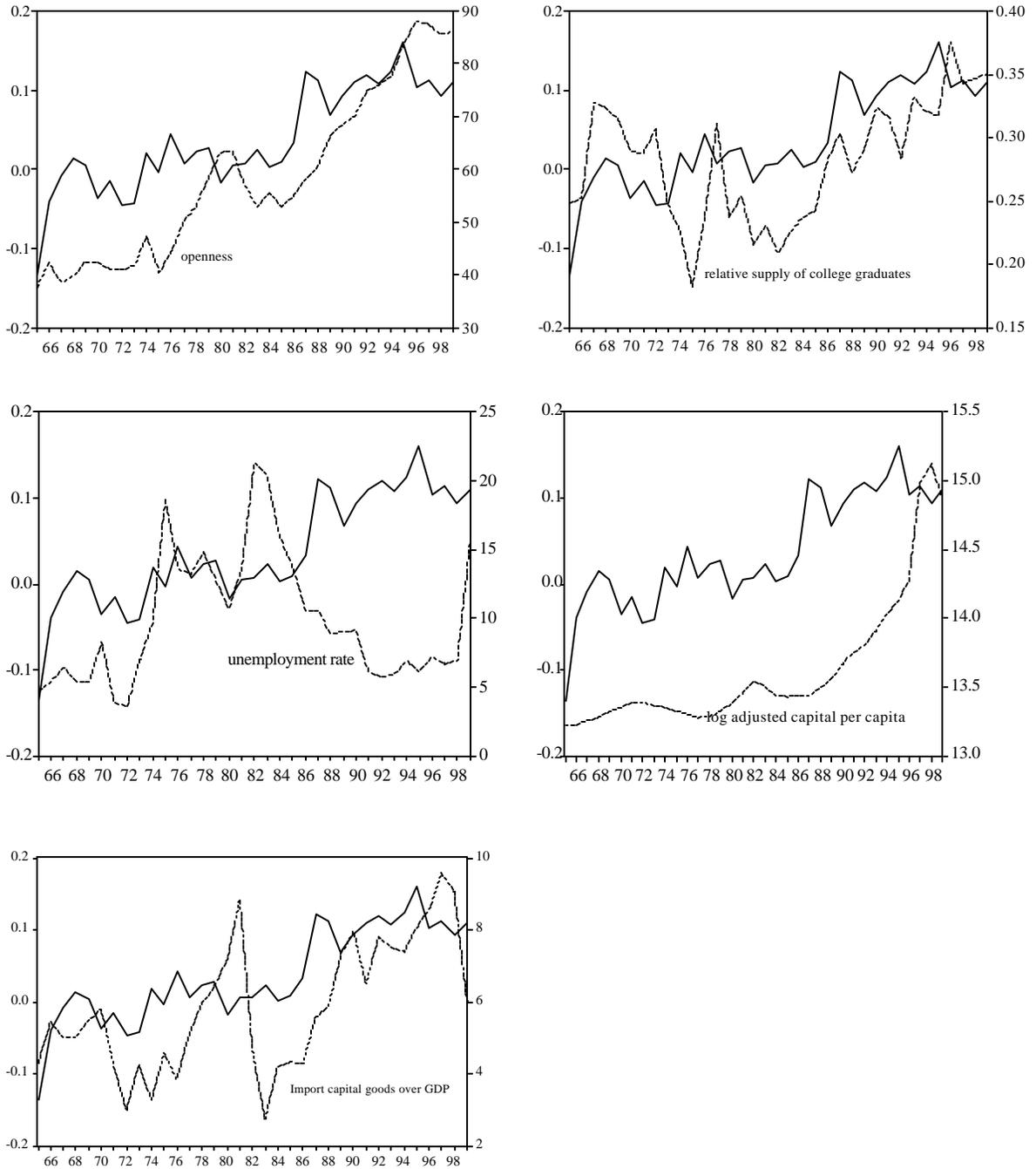


Figure 5
(continued)



From looking at the different graphs some explanations appear to be in trouble. That is the case of unemployment, minimum wage and the relative price of textiles. In table

4 we look at appropriate statistical test. We test the hypothesis that each explanatory variable contains a unit root. The first two columns show the results of these tests (under the assumption of no trend and trend). The third and fourth columns show the results of the tests of cointegration. We follow Engle and Granger (1987) and applied the adjusted Dickey-Fuller tests to the residuals of each regression.

Table 4
Unit root and cointegration tests
(1960 – 1999)

	τ_u	τ_t	No cointegrated with U-S return	No cointegrated with U-P return
Minimum Wage	-1.99	-2.40	-1.63	-1.99
Professionals/Blue-Collars	-0.79	-3.04	-3.31	-2.54
Non tradables/GDP	-0.12	-3.31	-2.95	-3.41
Relative price of textiles	-1.52	-1.29	-1.34	-2.11
Openness	0.24	-2.23	-3.33	-2.46
Supply univer/secondary	-1.82	-2.16	-1.55	
Supply univer/primary	-0.13	-2.14		-2.45
Unemployment	-2.11	-2.19	-1.25	-1.84
Log of capital per capita	-0.05	-1.48	-2.31	-2.09
Import capital goods/GDP	-2.39	-2.94	-2.63	-2.74

Note: Critical values for unit root if no trend is assumed are -3.612 (1%), -2.940 (5%), and -2.608 (10%). If trend is assumed the values are -4.22 (1%), -3.53 (5%), and -3.20 (10%). In the case of the tests for cointegration, the critical values are -3.07 (10%), -3.37 (5%) and -3.96 (1%).

The tests show that the different variable with are well described as unit root processes (perhaps with the exception of non tradables/GDP). On the other hand, the evolution of the differential in the return to university education as compared to secondary education could be explained by the evolution of openness and the structure of employment in Chilean firms.

4 Returns to education: a preliminary global perspective

The relationship between education and income is well established. The traditional models of human capital (for example, Mincer 1974) define the following expression for this relationship:

$$\log Y_s = \log Y_0 + \sum_{i=1}^s \log(1 + r_i) + v$$

where r_i is the rate of return of the i th year of schooling. This expression can be approximated by:

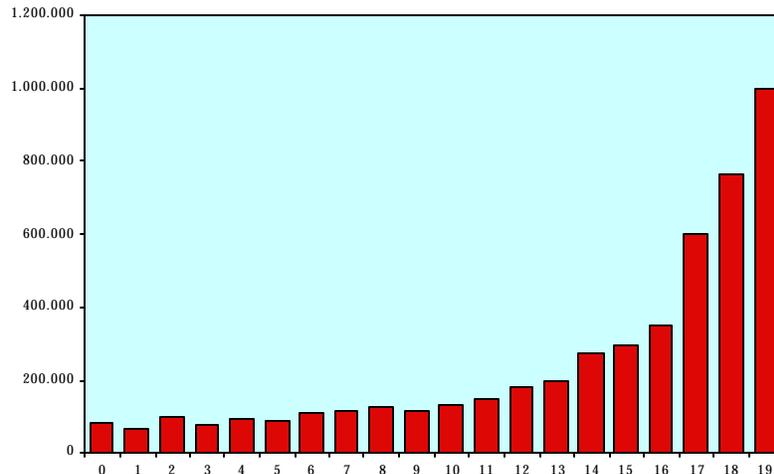
$$\log Y_s = \log Y_0 + rs + v$$

Having done this, we can write down an expression for the distribution of earnings. Under the assumption of no correlation of v with schooling or the return we have that

$$\text{Var}(\log Y_s) = \bar{r}^2 \text{Var}(s) + \bar{s}^2 \text{Var}(r) + 2\bar{r}\bar{s} \text{cov}(r, s) + \text{Var}(v)$$

If the dispersion in schooling increase then income inequality should increase. But more interesting an increase in average schooling may reduce inequality only if there is a negative covariance between schooling and return to education. There is empirical evidence that confirms that negative covariance. However, the situation of the returns to education in Chile bring some doubts to the discussion. Figure 6 suggests that the relationship between education and income looks more like an exponential than like a concave function. This is corroborated by Table 5. It indicates the marginal returns to different educational levels. The conceptual framework is the model of human capital presented above. Those returns are estimated through a spline regression that assumes different returns for elementary, secondary and university education. The data comes from the June surveys of employment of the University of Chile⁶. For each year between 1960 and 1999 we estimate a regression, among men that are wage earners, that includes not only their educational attainment but also characteristics like experience, working hours, marital status, industry and a broad definition of occupation. The table presents the average return in each decade.

Figure 6
Monthly labor income of men in 1998
(25 to 54 years, full time workers, controlled by experience)



⁶This survey is carried every three months in the city of Santiago. We choose the June survey because it includes a supplement on incomes.

Table 5
Marginal returns to different educational levels

	Primary	Secondary	University
1960s	10.2	19.4	12.8
1970s	10.1	19.9	19.9
1980s	7.6	18,6	18.6
1990s	3.6	9.9	21.2

Both figure 6 and table 5 shouldn't be a surprised. Figure 4 anticipated these results. A look at different studies around the world show that the Chilean case although uncommon is not unique. Countries with such return profile tend to be unequal which is expected from the variance of income equation. In table 6 the structure of returns to education for different regions are shown.

Table 6
Private returns to education
(last available data: unweighted averages)

	Primary	Secondary	University
Sub Saharan Africa	41,3	26,6	27,8
Asia*	39,0	18,9	19,9
Europe/Middle East/ North Africa*	17,4	15,9	21,7
Latin America and Caribbean	26,2	16,8	19,7
OECD	21,7	12,4	12,3
World	29,1	18,1	20,3

* Exclude OECD countries.
Sources: Psacharopoulos (1994), Beyer (2000).

It is interesting to note that the counties with “uncommon” structure of the returns to different levels of education are heavily represented in Latin America⁷. In what follows we explore the extent that inequality of income in Latin America could be explained by the dispersion in education, and the returns to education. This has to be understand as an explanatory research since the quantity and quality of the data on returns to education is poor.

⁷ Recent preliminary research by Sapelli (2000) in Paraguay and Venezuela tend to confirm this impression.

Table 7
The effects of the returns to education on inequality
(Panel regressions for 1960, 1970, 1980, and 1990)

	Model 1	Model 2	Model 3	Model 4
LogGDP	0.3525 (0.103)	0.3097 (0.089)	0.354 (0.090)	0.4087 (0.119)
LogGDP ²	-0.0241 (0.0065)	-0.0201 (0.0055)	-0.022 (0.0055)	-0.025 (0.0073)
Primary			-0.019 (0.0036)	-0.006 (0.004)
Secondary			0.0028 (0.0076)	-0.021 (0.008)
University			0.0039 (0.034)	0.0723 (0.034)
Secondary return				0.003 (0.0006)
University return				0.002 (0.0007)
Reg. dummies				
Latin America		0.1171 (0.016)	0.091 (0.016)	0.076 (0.017)
SE Asia		-0.011 (0.016)	-0.030 (0.016)	-0.011 (0.016)
Sub-Sahara		0.112 (0.018)	0.09 (0.021)	0.081 (0.029)
Survey dummies				
Expenditure		-0.021 (0.014)	-0.049 (0.014)	-0.049 (0.014)
Net Income		-0.060 (0.014)	-0.072 (0.013)	-0.066 (0.014)
Individuals		-0.042 (0.011)	-0.030 (0.01)	-0.017 (0.01)
R ² (N)	0.11 (47) 0.12 (53) 0.11 (68) 0.17 (78)	0.39 (46) 0.58 (52) 0.59 (67) 0.56 (78)	0.49 (38) 0.66 (51) 0.69 (61) 0.61 (72)	0.59 (23) 0.68 (37) 0.86 (38) 0.76 (43)

Note: standard errors in parentheses. Different constants terms (not reported) are considered in each equation.

The empirical strategy consists in estimating seemingly unrelated regressions with the Gini coefficient as a dependent variable. For those purposes we use the Deininger-Squire database. We construct regressions for 1960, 1970, 1980 and 1990 using the closest Gini coefficient available to each year. We choose only those that Deininger and Squire (1996) considered as appropriate⁸. Independent variables are the educational attainment of

⁸They classify the data according to the accuracy of the information and the quality of the source.

the population 25 and over from the Barro-Lee database, specifically primary, secondary and university education. We include the data on returns to education collected by Psacharopoulos (1994), specifically we construct the difference in returns to university education and secondary education⁹. Additionally, the regressions are controlled by GDP per capita and its square (the Kuznets hypothesis). Several regional and type of survey dummies are incorporated. Table 7 summarizes the results. High returns to secondary and university returns tend to increase inequality. At the same time those high returns reduce the impact of primary education on inequality. It also shows that university education once the returns to education are controlled can have increase inequality significantly.

5. Conclusions

In Chile wage inequality is high and has increased mildly in the last decades. Important changes however have occurred within the distribution. The bottom half of the wage distribution is today more compressed than in the past. At the same time, the top half is more dispersed today than in the past. These results appear to be mainly the consequences of changes in the returns to education. Specifically the returns to secondary and elementary education have fallen dramatically while the return to university education has increased substantially from a 13% in the 1960s to a 22% in the 1990s. As a result of these changes the differentials in educational returns increased strongly.

An attempt to explain the causes behind the evolution of these differentials is made. Nine potential explanations are investigated. Using cointegration techniques we find that the evolution in the differential of returns between university education and secondary education could be only linked to the increase in openness in Chile and to the “professionalization” of Chilean firms. On the other hand, the evolution of the differential of returns between university and primary education could be only related to the increase in the non tradable sector in Chile. Recent Chile’s forgettable performances in international tests that represent, at least indirectly, an evaluation of Chile’s educational system suggest the incapacity of Chilean workers to deal with the labor requirement of a more globalized economy. It shouldn’t be a surprise if the ultimate cause of the evolution in returns to education is a very limited educational system. Several anecdotal evidence suggests that Chilean firms hire overqualified people (i.e. university graduates) to develop tasks that could be done by well educated high school graduates.

If there is a positive covariance between returns to schooling and schooling increases in educational attainment could lead to increases in inequality. This factor could be behind the inequality of incomes in Latin America, specially if we take into account that in spite of the increases in schooling in the region inequality did not go down in the last decades. We look at preliminary evidence that the returns to education could play a non insignificant effect on inequality.

⁹Data limitations do not allowed a more careful analysis.

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